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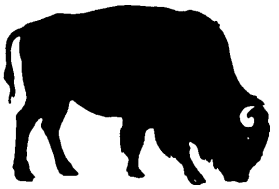
BIOLOGICAL RESEARCH ON BISON AND BRUCELLOSIS IN THE GREATER YELLOWSTONE ECOSYSTEM



The successful long-term management of bison and brucellosis in the Greater Yellowstone Ecosystem is influenced by many issues relating to the epidemiology of brucellosis and bison population ecology. In an effort to develop a more comprehensive understanding of these issues, scientists from U.S. Geological Survey's (USGS) Biological Resources Division are collaborating with university, state, and federal groups on a number of studies. Ecological studies focus on forage availability, habitat use, and bison population dynamics. Brucellosis research includes examining the risk of transmission of the disease from wildlife to cattle, identification of exposed animals in the field, and the safety of vaccines to wildlife species. The information gained from these studies assists Park managers, federal and state officials, Congress, and others in developing future bison management plans.

Below are brief summaries of the current bison and brucellosis studies being conducted by USGS and collaborating scientists.

BISON ECOLOGY

Determining forage availability and habitat use patterns for bison in the Hayden Valley of Yellowstone National Park.

Scientists at Montana State University and USGS are studying bison-vegetation interactions and testing the accuracy of various sampling methods in Hayden Valley, the central area of bison summer range in Yellowstone National Park. Bison preferences (for cow-calf herds and bull groups), seasonal use patterns, and consistency-of-use patterns at the landscape level will be determined from overlays of radio-collared bison on GIS layers related to vegetation type, topography, snow-melt patterns, and forage biomass. The resulting information will be used in the development of a bison-vegetation interaction model. A pilot study on this topic is currently being conducted in the Madison-Firehole Range of Yellowstone National Park.

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Seasonal movements and habitat selection by bison in Yellowstone National Park.
Approximately 3,000 bison currently inhabit Yellowstone National Park. Three major subpopulations exist, each with discrete summer ranges but which commingle on winter ranges. USGS scientists are radio-collaring individual bison in order to study the pattern and timing of each subpopulations' seasonal movements relative to environmental factors. The information will assist managers in identifying areas within the Park most suitable for bison at select times of the year.

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Development of aerial survey methodology for bison population estimation in Yellowstone National Park.
Scientists from Montana State University are developing and testing a number of aerial survey techniques for estimating bison populations and other parameters in Yellowstone National Park. This study includes identifying high and low density strata and appropriate sampling techniques for each strata, comparing surveys conducted during the period of summer breeding and winter range aggregations, identifying conditions that provide the best opportunities for accurately counting bison, and exploring techniques for estimating the proportion of animals detected during each survey. Products of this research will include development of statistically rigorous survey methodologies, estimates of Park-wide bison populations, and specific routine population monitoring recommendations for managers.

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Spatial-dynamic modeling of bison carrying capacity in the greater Yellowstone Ecosystem-A synthesis of bison movements, population dynamics, and interactions with vegetation.
Estimates of ecological carrying capacity for bison are needed to interpret past increases in bison population sizes and ranges, and to assess the risks of future increases and movements within and across Yellowstone National Park boundaries. Population increases up until 1997 may have been responses to available carrying capacity, climate, and the nomadic tendencies of bison, as well as the plowing and grooming of roads and trails in the winter and resultant effects on bison movements, energetics, and survival. The effects of bison on vegetation and other ecosystem components must also be considered. Colorado State University scientists are developing a

spatial-dynamic ecosystem model as a means to integrate these components, provide a broader explanation for past changes, and explore possible future scenarios.

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Population Characteristics of Yellowstone National Park Bison.
Samples secured from bison slaughtered beyond the boundaries of Yellowstone National **Park** during the 1996-97 winter provide scientists with an opportunistic source of information on the population ecology of Yellowstone bison. Data are obtained on the age structure of bison herds, the reproductive rate, fetal sex ratio, and prevalence of brucellosis. Blood samples are used to explore the feasibility of using Polymerase Chain Reaction (PCR) techniques to determine the presence of *Brucella abortus.* In addition, tissue samples are used to assess the herd's genetic composition and the prevalence of a genome rendering bison immune to brucellosis.

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Bison interactions with elk and predictive models of bison and elk carrying capacity, snow models, and population management scenarios in the Jackson Valley.
USGS and university scientists are studying bison and elk carrying capacity and range potential in the Jackson Valley of Yellowstone National Park. Currently, elk and bison are artificially fed at several sites in the Valley. Managers seek to reduce the concentrations of the two species at these feeding grounds which may contribute to high seropositive rates of brucellosis. Scientists are developing models of typical snow depths and habitat suitability models that, in concert with geographic information systems (GIS), will enable them to predict the natural winter habitat of elk and bison in the absence or reduction of feeding grounds. The group is also sampling biomass and availability of forages that will enable them, with the use of a spatially explicit ecosystem model called SAVANNA, to predict the elk and bison numbers that might be supported under a variety of feeding scenarios. The information will provide managers with predictions for various management scenarios aimed at reducing interactions and the presence of brucellosis in elk and bison.

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Bison use of groomed roads in Yellowstone National Park.
A two-year field study has been initiated by faculty and graduate students from Montana State University to investigate the ecological effects of the use of groomed roads by bison during the winter. The study includes intensive observations of bison activity and behavior to test a number of hypotheses dealing with the effects of snowpack and use of groomed roads on bison foraging activity and distributional shifts throughout the winter. The study is being conducted in the upper Madison River drainage, a major wintering area for bison and a primary area of concern for bison exiting the Park. Products of this research will include quantifying bison use of groomed roads during the winter, identification of major distributional shifts and the patterns of movements causing such shifts, identifying major travel corridors, and other data useful in evaluating the effects of groomed roads on bison ecology.

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Statistical analysis and synthesis of 30 years of bison data.
Using statistically rigorous methods, scientists are analyzing over 30 years of bison data collected by USGS biologist Mary Meagher. The information will shed light on issues such as how bison are influenced by natural regulation and whether bison use of groomed and packed winter roads in Yellowstone National Park affect bison population dynamics.

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BRUCELLOSIS

Reproduction and demography of brucellosis-infected bison in the southern Greater Yellowstone Ecosystem.
Researchers are examining the influence of brucellosis on the demographic and reproductive characteristics of the Jackson bison herd. Radio-collared male and female bison are periodically sampled for brucellosis status and pregnancy. Ages are determined through tooth eruption and

tooth sizes. Males are monitored for their participation in the rut. Bison herds are monitored for distribution, calving success, and calf growth rates.

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Genetic analysis of *Brucella* from bison and the generation of a PCR-based diagnostic system for epidemiological and ecological studies.

Researchers are using the Polymerase Chain Reaction (PCR) to genetically analyze DNA from *Brucella* isolates derived from bison, cattle, and other animal hosts. These studies will aid researchers in determining how many species are in the genus *Brucella* and whether the genus comprises host-specific species and/or isolates. The genetic studies will be used to develop an effective, highly-sensitive, PCR-based diagnostic system to detect the presence of *Brucella* in blood, body fluids, and environmental samples. This diagnostic system will allow managers to determine if bison are currently infected with *Brucella* and the diversity of isolates or species present in the animals. Future studies will result in field applicable diagnostic systems to rapidly detect *Brucella* and discriminate live and dead bacterial cells.

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Molecular Biology Project.

Present research activities are directed toward: 1) adapting the rapid diagnostic assays to identify *Brucella* in biological samples (tissues, blood, milk, etc.) and developing DNA tests which distinguish among bovine *Brucella* strains for epidemiology, 2) developing reagents to eliminate false positive reactions in the serologic tests for brucellosis required at market, and 3) determining the genetic basis of the ability of *B. abortus* to cause disease and persist in animals and, therefore, how to design safe wildlife vaccines to eliminate bovine brucellosis in reservoir populations.

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Epidemiology and pathogenesis of brucellosis in Yellowstone National Park.
Researchers are studying radio-collared female bison to assess epidemiological factors involved in the transmission of brucellosis. Activities involve 1) assessing the brucellosis status of adult females and relating it to calving success and brucellosis status of calves, 2) examining calving sites for birth products and potential contamination of the environment (soil and vegetation are collected and cultured for *Brucella),* and 3) monitoring post-partum behavior of bison and behavior of other wildlife species to assess the degree of contact with and/or consumption of birth products. The results are important in assessing the risk of transmission of brucellosis from wildlife to cattle.

Researchers took extensive samples fiom bison that were shot outside the Park during the 1996-97 winter, mainly from seropositive female bison. These samples are being used to determine: 1) the relationship between serology and infection, and 2) which tissues are most likely to harbor *Brucella.*

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Evaluating risk factors for transmission of brucellosis from bison to elk in Yellowstone National Park.
Management of brucellosis in bison could potentially be complicated by transmission of the disease between elk and bison. Scientists from Montana State University are assessing the potential for such interspecies disease transmissions in the Madison-Firehole area of Yellowstone National Park. This area was selected because it is the major wintering ground for approximately 1000 bison as well as an estimated 600-800 nonmigratory elk. The restricted wintering habitats available in this area, combined with high densities of both elk and bison, suggest potential risk of interspecies transmission of brucellosis would be highest in this area. The study includes serological surveys; studies of elk and bison distributional shifts and population estimates; habitat

affinities of each species and how these change seasonally and with varying snowpack conditions; and measures of direct association and interaction between the two species during spring when probability of *Brucella* transmission is believed to be the highest. This research will be useful in developing long-term management plans for minimizing the threat of brucellosis transmission from wild ungulates to livestock in the Yellowstone area.

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Safety of *Brucella abortus* RB51 vaccine in pregnant bison. Efficacy of parenteral RB51 in Yellowstone bison.

A key factor in the control of brucellosis in wildlife will likely be the use of an effective vaccine in bison and elk. The focus of this study is on the safety of the modified live bacteria vaccine RB51 to pregnant Yellowstone bison. Bison were split into two treatment groups and one control group, given high or low doses of RB51 or saline, and transported to holding facilities to monitor calving. At calving, each bison was immobilized and sampled for evidence of field strain *Brucella* and RB51. Adult bison have been re-bred and will be challenged with virulent *Brucella* in 1998.

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Biosafety and persistence of RB51 parentally vaccinated bison calves.

Calves vaccinated with RB51, a modified live vaccine for brucellosis, as a consequence of routine management are being examined for persistence, shedding, transmission, and pathology caused by the vaccine. Persistence and shedding is determined by culture of over 30 different tissues, fluids, and swabs of vaccinated calves at different intervals. Pathology is determined through gross and microscopic examination of tissue sections. The transmission of the disease is assessed by immobilizing adult females in the herd and determining RB51 specific antibody responses.

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Prevalence of brucellosis in southern Greater Yellowstone Ecosystem moose.
Moose are considered a species sensitive to brucellosis. As part of a collaborative effort in the southern Greater Yellowstone Area, including Grand Teton National Park, scientists are utilizing data from a moose ecology project that involves capturing and radio-collaring moose to: 1) assess seroprevalence of *Brucella* antibodies, and 2) determine pregnancy and calving rates of moose coexisting with bison and elk infected with brucellosis.

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OTHER BISON/BRUCELLOSIS STUDIES

The following includes information on additional bison and brucellosis projects not being funded or staffed by the U.S. Geological Survey (USGS). It is not intended to be a comprehensive list, but highlights other studies currently known by USGS employees.

Brucellosis Vaccine Project.
The USDA Animal Research Service's National Animal Disease Center has a number of ongoing research projects in bison and cattle to evaluate the safety and efficacy of the *B. abortus* strain RB51 vaccine. In addition to evaluating the protection induced by vaccination with strain RB51, these studies are also evaluating the effects of vaccine dosage, safety in adult bulls, potential for vaccine latency, and immune responses following vaccination.

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Survival of *B. abortus* in the environment and disappearance rates of fetuses in Wyoming.
The ability of *B. abortus* to survive in the environment is being examined by simulating abortions due to brucellosis and sequentially sampling the fetuses to determine how long bacteria can be cultured and in what amounts. Environmental conditions are similar to those in the Greater Yellowstone Area (GYA). In addition we are determining how long fetuses remain in the environment of the GYA until they are removed by scavengers. These complementary studies are designed to provide information that could be used in developing models of brucellosis in the GYA and for risk assessment.

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Snowpack distribution across lower elevations of Grand Teton National Park and National Elk Refuge.
Snowpack data, specifically in the form of snow water equivalent (SWE), has been collected, estimated, and analyzed throughout the Park and Refuge. Additional climatic data from a variety of sources has been accessed and made available, including air temperature, snow depth, and

precipitation. This data is being utilized to develop a predictive model of SWE throughout the area, an index of winter severity, and an index of soil moisture deficit. Migration patterns of bison and elk are being correlated to SWE conditions as predicted by these indices.

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Investigation of snowpack distribution across Yellowstone National Park.
The snowpack distribution across the Park, drainages that flow into the Park, and the winter range areas north of the Park is being determined using currently measured snow courses, SNOTEL sites, and climatological stations. Calculations are being made of growing degree days, soil moisture deficits, and winter severity indices. This data will be correlated with migration patterns, geographic ranges, and population numbers, historically, for bison and elk.

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